REMARKS

In the last Office Action, claims 1-7 and 13-24 were rejected under 35 U.S.C. §103(a) as being unpatentable over US 5,407,281 to Chen in view of US 3,912,503 to Schumacher. Claims 8-11 were rejected under 35 U.S.C. §103(a) as being unpatentable over Chen in view of Schumacher and further in view of US 6,176,618 to Kawawada et al. (Kawawada).

In accordance with this amendment, independent claims 1 and 14 have been amended to further patentably distinguish over the prior art, and the specification has been revised to conform to the amended claims. More particularly, claims 1 and 14 have been amended to define the level of hardness on one or both of the opposite surfaces of the rotating member and the hollow member, which imparts high machinability and wear resistance to these parts and enables the manufacture of a hydrodynamic bearing having a high degree of rotational accuracy and high reliability. Support for this claim amendment can be found, for example, in Fig. 4 of the drawings and pages 27-28 of the specification.

As the surface hardness of the rotating member and/or the hollow member has been an issue throughout prosecution, the delimiting of these claims to include the range of surface hardness does not raise a new issue that would require further search or consideration. Applicants, therefore, respectfully request entry of this amendment and

reconsideration of their application in light of the amended claims.

The present invention pertains to a hydrodynamic bearing having a hollow member, a rotatable member disposed within a hollow portion of the hollow member, and hydrodynamic pressure-producing means, for example, in the form of hydrodynamic pressure-producing grooves formed on one or both of the hollow member and the rotatable member, to produce hydrodynamic pressure on fluid interposed between opposite surfaces of the hollow member and the rotatable member. More particularly, the present invention relates to making one or both of the hollow member and the rotatable member of a special stainless steel having a composition selected to impart to the steel the property of undergoing plastic deformation when the surface of the steel is pressed and, in response to pressing the surface, the surface hardens substantially.

As described in the specification, applicants have discovered that when the surface of this special stainless steel is pressed by a load in the range of 1.5 to 5 tons, the surface undergoes plastic deformation resulting in substantial hardening of the surface to a level of 400-430HV, which is believed to be caused by a phase transformation from austenite to martensite. This property of the special stainless steel is used in the present invention to selectively harden opposed

or opposite surfaces of the hollow and rotatable members and is preferably utilized by press-forming the surface of the special stainless steel to plastically deform the surface to form the hydrodynamic pressure-producing grooves while press-hardening the surface to a hardness of 400-430HV. As a consequence, the hollow member and the rotatable member have significantly improved wear resistance as well as high machinability, thereby enabling the manufacture of hydrodynamic bearings having high rotational accuracy and high reliability for use in high-speed hard disk drives.

Independent claim 1 is directed to a hydrodynamic bearing having a hollow member, a rotating member that includes a rotating portion disposed inside a hollow portion of the hollow member, a fluid interposed between the hollow and rotating members, hydrodynamic pressure-producing means acting on the fluid between opposite surfaces of the hollow and rotating members to produce hydrodynamic pressure between the opposite surfaces of the members, and a seal portion to prevent leakage of the fluid. Claim 1 further requires that at least one of the rotating and hollow members is made of a stainless steel containing from 12 to 16 weight% chromium and from 6 to 10 weight% manganese, and wherein at least one of the opposite surfaces of the rotating and hollow members has been hardened to a surface hardness of 400-430HV by plastic deformation processing.

Independent claim 14 is directed to a hydrodynamic bearing having a hollow member, a rotatable member disposed in a hollow interior portion of the hollow member, and a fluid disposed in the hollow interior portion between opposed surfaces of the hollow and rotatable members, wherein one or both of the hollow and rotatable members are made of a stainless steel whose surface undergoes plastic deformation and hardening when subjected to pressing, and wherein one or both of the hollow member and the rotatable member that are made of the stainless steel have hydrodynamic pressure-producing grooves formed in the surface thereof, the grooves being formed by pressing the stainless steel surface to plastically deform the surface to form the grooves while press-hardening the surface to a surface hardness of 400-430HV.

Independent claim 21 is directed to a hydrodynamic bearing having a hollow member, a rotatable member disposed in a hollow interior portion of the hollow member, and a fluid disposed in the hollow interior portion between opposed surfaces of the hollow member and the rotatable member, wherein one of both of the hollow member and the rotatable member are made of stainless steel and have hydrodynamic pressure-producing grooves formed in the surface thereof, each surface that has hydrodynamic pressure-producing grooves formed therein having a martensite phase structure.

The teachings of the prior art, whether considered alone or in combination, do not disclose or suggest the presently claimed invention.

The primary reference to Chen discloses a hydrodynamic bearing having a hollow member 14, a rotating member 12 having a rotating portion disposed inside the hollow portion of the hollow member 14, and hydrodynamic pressure-producing groove 22, 24, 50 formed in the outer surface of the rotating member 12. Chen discloses that the rotating member (shaft) 12 may be made of a stainless or carbon steel alloy and the hollow member (sleeve) 14 made of a bronze alloy, or the shaft 12 and the sleeve 14 may both be made of carbon steel, with one or both elements being suitably hardened (column 6, line 65 - column 7, line 1). Chen further discloses that the grooves are formed by micro-machining, electro-discharge-machining, etching or coining. As noted by the Examiner, coining is a type of pressing operation and, more specifically, a stamping operation. However, Chen does not disclose use of a stainless steel having the property of undergoing plastic deformation and hardening when subjected to pressing to a surface hardness of 400-430HV, as required by claims 1 and 14, or provision of grooved surfaces having a martensite phase structure, as required by claim 21. Instead, Chen teaches use of well-known stainless steels as described, for example, on pages 1-4 of the present specification.

The secondary reference to Schumacher has been applied for its teaching of a stainless steel having a chromium content between 12 and 16 weight% and a manganese content between 6 and 10 weight% for the purpose of providing good wear resistance and outstanding resistance to galling. However, there is no teaching or suggestion whatsoever in Schumacher that the stainless steel disclosed therein has the property of undergoing plastic deformation by exerting a pressing force on the surface thereof accompanied by hardening to a surface hardness of 400-430HV, as required by claims 1 and 14, or provision of grooved surfaces having a martensite phase structure, as required by claim 21. The Schumacher stainless steel does not possess these properties.

Insofar as disclosed, the Schumacher steel retains its austenitic structure throughout processing and does not, when subjected to pressing, undergo plastic deformation accompanied by surface hardening. Schumacher discloses at column 4, lines 32-35 that at least 3% nickel is required in order to assure an austenitic structure, and that preferably 4% and more preferably 6% nickel is added for this purpose. By contrast, the composition of the special stainless steel utilized in the present invention has no more than 2% nickel, as described on page 26 of the present specification and explicitly recited in claim 16, which has not been addressed in the rejection. Moreover, Schumacher describes at column 3,

lines 36-44, that the balance between the chromium, nickel, manganese, silicon and nitrogen is critical in every sense, and that omission of one of these elements, or a departure of any of these critical elements from the ranges disclosed, results in loss of one or more of the desired properties of the stainless steel.

There is simply no teaching or guidance in Schumacher that would have led one of ordinary skill in the art to modify the stainless steel composition to achieve a special stainless steel like that of the invention which undergoes plastic deformation when pressing the surface with the result that the surface hardens to a hardness of 400-430HV, or which exhibits a press-hardened surface having a martensite phase structure. Thus even if Chen were modified in view of Schumacher in the manner proposed, the modified hydrodynamic bearing would not replicate that required by claims 1-11 and 13-24.

Kawawada has been cited for its teaching of a motor device in conjunction with a hydrodynamic bearing; however, the reference does not cure the deficiencies of Chen and Schumacher insofar as concerns claims 1-11 and 13-24.

In light of the foregoing, the application is now believed to be in allowable form. Accordingly, reconsideration and entry of this amendment together with passage of the application to issue are respectfully requested.

Respectfully submitted,

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OCTOBER 10, 2007
Date